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HETEROSIS FOR GRAIN YIELD AND ITS IMPORTANT COMPONENTS IN AROMATIC RICE (*ORYZA SATIVA* L.)

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ABSTRACT

Eight genotypes consisting three Basmati varieties viz, Basmati Kasturi, Basmati 370 and Basmati with five Manipur scented rice landraces viz, Chakhao Poireiton, Chakhao, Chakhao Amubi, Ching Chakhao and Chakhao Angangba were crossed in 8X8 diallel fashion without recieprocal producing twenty eight F_1 hybrids and were evaluated to estimate mid parent heterosis for eleven yield contibuting characters. The best crosses which have the highest magnitude of mid-parent heterosis for grain yield per plant were Chakhao Poireiton x Chakhao Amubi(79.77), Chakhao Amubi x Ching Chakhao(79.11) and Chakhao Poireiton x Basmati(59.56). Basmati 370 x Ching Chakhao (-23.29)showed high magnitude of negative heterosis for plant height at maturity, Basmati x Ching Chakhao showed highest magnitude of positive heterosis for total number of spikelets per panicle (49.23) and total number of filled grains per panicle (65.77).

KEYWORDS: Heterosis, Grain Yield & Aromatic Rice

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Original Article

INTRODUCTION

Rice being self-pollinated plant show considerable amount of heterosis. Hybrid vigour in rice was first reported by Jones (1926). The study on the magnitude of heterosis is the most important prerequisite for undertaking any heterosis breeding programme (Saravanan *et al*., 2004). Heterosis has been commercially exploited in rice with a yield advantage of 20-25% over the best pure lines (Rather *et al*., 2001). The Basmati varieties are widely grown in Punjab, Haryana and western Uttar Pradesh while the small and medium-grained scented varieties like Chakhao, Chakhao Amubi, Chakhao Poireiton are indigenous in Manipur. The Basmati and aromatic landraces of Manipur possess a similar quality of having a pleasant aroma which fetches highest premium in the market and the black and white aromatic rices (Chakhao Amubi, Chakhao Poireiton and Chakhao Angouba) of Manipur have their importance as glutinous or sticky rice which are used for community feast as well as ceremonial purposes as a delicacy. The yield of the scented rice of Manipur are low and also it covers only less than 10% of the rainfed wetland area under local cultivars (Singh and Baghel, 2003). Basmati types are phylogenetically divergent (Khush *et al*., 1979) and aromatic rice of Manipurhave high genetic diversity (Roy et al., 2014) therefore hybridization between these diverse germplasm can give hybrid vigour. Hybridity per se did not harm grain quality in terms of physical and chemical characteristics as long as both parents possess acceptable grain quality(Khush et al., 1988)which is important for increasing the yield through exploiting heterosis without affecting the grain quality of scented rice of Manipur and Basmati.

MATERIALS AND METHODS

The experiment was conducted in the experimental farm of the Plant Breeding and Genetics, College of Agriculture, Central Agricultural University, Imphal. Eight aromatic rice genotypes possessing different morphological and productive attributes were studied in the experiment. Eight genotypes consist of three Basmati varieties *viz*, Basmati Kasturi, Basmati 370, Basmati and five Manipur scented rice landraces namely, Chakhao Poireiton, Chakhao, Chakhao Amubi, Ching Chakhao and Chakhao Angangba. These parents were crossed in diallel mating system excluding reciprocal during *kharif* 2009 and the resultant twenty-eight hybrids along with eight parents totalling thirty-six treatments were raised in RBD with three replications during *kharif* 2010. Observation were recorded on ten randomly selected competitive plant in each replication excluding the boarder plants. The thirty-six treatments were assessed for mid parent heterosis.Estimations of mid – parent heterosis were done for the following eleven characters *viz,* days to 50% flowering, days to 80% maturity, plant height at maturity, total number of tillers per plant, total number of spikelets per panicle, total number of filled grains per panicle, 1000 grain weight, panicle length, grain length, grain breadth, grain yield per plant.

RESULTS AND DISCUSSIONS

ANOVA

The analysis of variance for the diallel set of 28 F_1 (without reciprocals) and 8 parents for the studied characters are presented in Table 1 and it was revealed from the table that the studied diallel set differed significantly for all the eleven traits, indicating the good amount of genetic differences in the present material.

HETEROSIS

Heterosis is expressed in three ways, depending on the criteria used to compare the performance of a hybrid (Gupta, 2000). These three ways are mid-parent heterosis (the performance of a hybrid compared with the average performance of its parents), better parent heterosis or heterobeltiosis (the performance of a hybrid compared with that of the best parent in the cross) and standard heterosis (the performance of a hybrid compared with high yielding variety in the region).Performance of F_1 estimates of heterosis over mid parent (MP) for different characters in aromatic rice are presented in Table 2. Both positive and negative heterosis is useful in crop improvement, depending on the breeding objectives. In general, positive heterosis is desired for yield and negative heterosis for early maturity (Nuruzzaman *et al*., 2002)

Negative heterosis is desirable for days to flowering because this will make the hybrids to mature earlier as compared to parents. Basmati 370 x Chakhao, Chakhao Poireiton x Chakhao Amubi and Basmati Kasturi x Basmati 370 show significant negative heterosis which can be selected from F_1. The better performance of the hybrids for flowering was earlier reported by Rahimi *et al*. (2010) and Vaithiyalingan and Nandarajan (2010).

Like earliness in flowering, negative heterosis over mid parent value is also desirable for plant maturity period. For early maturity type, among 28 hybrids the best crosses which exhibited negative heterosis are Basmati 370 x Chakhao, Chakhao Poireiton x Chakhao Amubi and Basmati 370 x Ching Chakhao. Negative heterosis for early maturity has also been reported by Singh (2005) and Rahimi *et al*. (2010).

For total number of tillers per plant, the highest significant and positive heterosis was found in cross Chakhao Poireiton x Basmati in F_1 generation. It indicated the preponderance of non-additive gene action obviously more number of productive tillers per plant would contribute to high yield. Rao *et al.* (1996) reported highly significant heterotic effect over better and standard parents with respect to tiller number per plant which are in accordance with the present results.

However, a hybrid with longer panicle length is desirable, since the spikelets attached to primary and secondary branch would increase proportionately with the enhancement of panicle length. In the present study out of 28, 15 hybrids exhibited positive and significant mid-parent heterosis. Basmati 370 x Chakhao Amubi showed high mean heterosis to the extent of 36.44 % for panicle length. Total number of spikelets per panicle is one of the most important characters which directly influence the yield improvement. Among 28 hybrids tested, 11 F_1's exhibited significant and positive heterosis over mid parent for total spikelet's per panicle and 9 F_1 's for filled grains per panicle,Basmati x Ching Chakhao showed highest mid parent heterosis for spikelets per panicle and filled grains per panicle. Veni et al. (2003) also reported high heterosis for spikelets per panicle and filled grains per panicle. For 1000 grains weight, the highest significant and positive mid parent heterosis was found in Basmati 370 x Chakhao in F_1 generation. Rahimi *et al*. (2010) also reported significant and positive standard heterosis for 1000 grain weight

The highest heterosis for grain yield per plant were observed in Chakhao Poireiton x Ching Chakhao, Chakhao Amubi x Ching Chakhao, Chakhao Poireiton x Basmati, Chakhao Poireiton x Chakhao and Basmati x Chakhao angangba. High heterotic effects for grain yield per plant in rice were also observed by earlier researchers (Veni *et al*., 2003, Anand and Singh, 2002 and Singh, 2005). Among 28 hybrids tested, only 6F_1's exhibited significant and positive heterosis for grain length. The crosses which show significant and positive heterosis for grain length are Basmati Kasturi x Basmati 370, Basmati 370 x Basmati, Chakhao x Chakhao Amubi, Basmati Kasturi x Chakhao, Ching Chakhao x Chakhao Angangba and Chakhao Poireiton x Basmati and for grain breadth the highest and negative significant heterosis over mid parent was exhibited by Ching Chakhao x Chakhao Angangba for F_1 generation. Rahimi *et al*. (2010) also reported significant and positive standard heterosis for grain length and Singh (2005) reported significant and negative heterosis for grain breadth.

CONCLUSIONS

Heterosis function was responsible for the manifestation of heterosis in the hybrids for yield components in the present investigation. In the light of these studies one has to look at the aspects i.e. *per se* performance exhibited by the cross while selecting suitable hybrids. The superior parental combinations for various characters studied may be utilized for development of hybrids of high yield.

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APPENDIES

Table 1: Analysis of Variance for F_1 in a Half-Diallel Cross for Different Characters in Aromatic Rice

Source	d.f	Mean Sum of Squares										
		Days to 50% Flowering	Days to 80% Maturity	Plant Height (cm)	Total Number of Tillers per Plant	Total Number of Spikelets per Panicle	Total Number of Filled Grains per Panicle	1000-Grain Weight (g)	Panicle Length (cm)	Grain Length (mm)	Grain Breadth (mm)	Grain Yield per Plant (g)
Replication	2	1.75	6.29	9.70	7.02	0.33	2.12	0.65	0.01	0.04	0.005	0.31
Treatment	35	84.45*	150.00*	966.86*	103.20*	5120.84*	4119.81*	27.30*	27.00*	3.13*	0.073*	2204.40*
Error	70	4.35	2.23	0.37	0.33	3.25	1.36	0.03	0.06	0.04	0.001	0.39

***Signifies Significant at 5 %**

Table 2

	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1
Basmati Kasturi	**102.67**		**137.00**		**105.77**		**22.47**		**275.79**		**230.73**	
Basmati 370	**109.67**		**144.33**		**145.17**		**23.50**		**195.14**		**158.25**	
Chakhao Poireiton	**111.67**		**148.33**		**137.16**		**17.40**		**186.97**		**161.16**	
Chakhao	**114.67**		**153.33**		**169.74**		**22.20**		**201.77**		**166.63**	
Basmati	**95.00**		**122.00**		**94.04**		**21.53**		**155.26**		**134.28**	
Chakhao Amubi	**119.67**		**157.00**		**149.02**		**14.97**		**142.79**		**114.55**	
Ching Chakhao	**107.67**		**142.00**		**142.39**		**23.13**		**117.36**		**95.61**	
Chakhao Angangba	**107.67**		**142.33**		**134.45**		**16.60**		**175.28**		**166.18**	
Basmati Kasturi x Basmati 370	**99.67**	-6.12*	**133.33**	-5.21*	**108.36**	-13.64*	**18.16**	-20.96*	**303.06**	28.71*	**280.38**	44.16*
Basmati Kasturi x Chakhao Poireiton	**110.67**	3.27*	**146.33**	2.57*	**113.22**	-6.79*	**27.57**	38.29*	**149.56**	-35.36*	**142.15**	-27.46*
Basmati Kasturi x Chakhao	**117.33**	7.98*	**155.33**	7.00*	**111.47**	-19.08*	**33.70**	50.90*	**210.4**	-11.89*	**169.06**	-14.91*
Basmati Kasturi x Basmati	**103.67**	4.89*	**139.00**	7.34*	**111.81**	11.92*	**24.13**	9.70*	**223.12**	3.52*	**179.00**	-1.92*
Basmati Kasturi x Chakhao Amubi	**115.67**	4.05*	**153.33**	4.31*	**151.01**	18.53*	**23.30**	24.49*	**186.83**	-10.73*	**165.98**	-3.86*
Basmati Kasturi x Ching Chakhao	**114.67**	9.03*	**151.33**	8.48*	**114.07**	-8.07*	**39.50**	73.25*	**173.08**	-11.95*	**157.81**	-3.28*
Basmati Kasturi x Chakhao Angangba	**112.67**	7.13*	**148.33**	6.21*	**132.55**	10.35*	**21.50**	10.07*	**194.72**	-13.66*	**141.08**	-28.91*
Basmati 370 x Chakhao Poireiton	**110.33**	-0.30	**147.67**	0.91	**147.60**	4.56*	**20.03**	-2.04*	**173.95**	-8.95*	**154.22**	-3.44*
Basmati 370 x Chakhao	**100.67**	-10.25*	**134.33**	-9.74*	**131.35**	-16.58*	**23.27**	1.82*	**184.82**	-6.87*	**137.60**	-15.29*
Basmati 370 x Basmati	**112.67**	10.10*	**149.33**	12.14*	**149.27**	24.80*	**22.00**	-2.29*	**134.98**	-22.96*	**120.47**	-17.63*
Basmati 370 x Chakhao Amubi	**108.67**	-5.23*	**145.00**	-3.76*	**140.25**	-4.66*	**17.60**	-8.49*	**140.42**	-16.89*	**118.43**	-13.17*
Basmati 370 x Ching Chakhao	**102.67**	-5.52*	**135.00**	-5.70*	**110.29**	-23.29*	**31.17**	33.67*	**185.07**	18.45*	**154.38**	21.62*
Basmati 370 x Chakhao Angangba	**110.67**	1.84	**147.00**	2.56*	**139.73**	-0.06	**17.07**	-14.88*	**145.67**	-21.35*	**129.35**	-20.26*
Chakhao Poireiton x Chakhao	**113.67**	0.44	**151.33**	0.33	**127.56**	-16.87*	**31.00**	56.57*	**198.39**	2.07	**172.82**	5.44*
Chakhao Poireiton x Basmati	**105.67**	2.26	**139.00**	2.84*	**161.85**	40.01*	**34.37**	76.54*	**133.68**	-21.88*	**115.26**	-21.98*
Chakhao Poireiton x Chakhao Amubi	**107.67**	-6.92*	**142.33**	-6.77*	**146.62**	2.46*	**19.07**	17.82*	**128.89**	-21.83*	**116.02**	-15.84*
Chakhao Poireiton x Ching Chakhao	**112.67**	2.74	**149.00**	2.64*	**130.15**	-6.89*	**30.33**	49.67*	**194.27**	27.67*	**171.59**	33.66*
Chakhao Poireiton x Chakhao Angangba	**109.33**	-0.30	**146.00**	0.46	**149.95**	10.42*	**23.37**	37.45*	**118.36**	-34.65*	**98.27**	-39.96*
Chakhao x Basmati	**110.00**	4.93*	**145.33**	5.57*	**159.20**	20.71*	**20.30**	-7.16*	**226.26**	26.75*	**207.57**	37.96*
Chakhao x Chakhao Amubi	**115.67**	-1.28	**152.33**	-1.83	**140.90**	-11.59*	**29.47**	58.57*	**181.86**	5.56*	**141.45**	0.61
Chakhao x Ching Chakhao	**108.67**	-2.25	**143.33**	-2.93*	**158.57**	1.60*	**31.87**	40.59*	**188.36**	18.05*	**167.66**	27.87*
Chakhao x Chakhao Angangba	**109.67**	-1.35	**146.00**	-1.24	**145.04**	-4.64*	**17.30**	-10.82*	**137.72**	-26.95*	**124.32**	-25.29*
Basmati x Chakhao Amubi	**104.67**	-2.48	**139.33**	-0.12	**134.92**	11.02*	**21.33**	16.89*	**136.26**	-8.56*	**102.46**	-17.64*
Basmati x Ching Chakhao	**110.67**	9.21*	**147.33**	11.62*	**151.71**	28.33*	**26.57**	18.96*	**203.41**	49.23*	**190.55**	65.77*
Basmati x Chakhao Angangba	**109.67**	8.22*	**143.33**	8.45*	**152.05**	33.09*	**27.53**	44.41*	**186.69**	12.96*	**155.51**	3.51*
Chakhao Amubi X Ching Chakhao	**114.00**	0.29	**143.00**	-4.35*	**133.83**	-8.15*	**24.97**	31.06*	**135.72**	4.34*	**135.65**	29.10*
Chakhao Amubi X Chakhao Angangba	**116.67**	2.64	**153.00**	2.23*	**123.46**	-12.89*	**17.23**	9.19*	**143.29**	-9.90*	**129.27**	-7.90*
Ching Chakhao X Chakhao Angangba	**108.67**	0.93	**143.33**	0.82	**143.41**	3.60*	**19.47**	-2.01*	**138.00**	-5.69*	**132.82**	1.47
S.Ed. for MP		**1.47**		**1.06**		**0.43**		**0.41**		**1.27**		**0.83**
C.D. (0.05)		**3.02**		**2.16**		**0.89**		**0.83**		**2.61**		**1.69**

Variety/ Crosses	1000- Grain Weight (g)		Panicle Length (cm)		Grain Length (mm)		Grain Breadth (mm)		Grain Yield per Plant (g)	
	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1	Mean P/F_1	% M.P F_1
Basmati Kasturi	**26.04**		**27.50**		**10.38**		**2.29**		**111.56**	
Basmati 370	**28.57**		**25.35**		**9.45**		**2.50**		**113.96**	
Chakhao Poireiton	**27.88**		**27.20**		**9.65**		**2.45**		**73.26**	
Chakhao	**21.66**		**34.44**		**8.64**		**2.40**		**96.99**	
Basmati	**28.06**		**24.76**		**11.50**		**2.12**		**83.93**	
Chakhao Amubi	**27.95**		**26.64**		**10.40**		**2.30**		**47.49**	
Ching Chakhao	**33.20**		**25.76**		**9.61**		**2.49**		**67.09**	
Chakhao Angangba	**32.28**		**26.39**		**9.61**		**2.68**		**89.31**	
Basmati Kasturi x Basmati 370	**30.66**	12.30*	**29.55**	11.82*	**12.32**	18.53*	**2.14**	-6.60*	**151.50**	34.36*
Basmati Kasturi x Chakhao Poireiton	**23.40**	-13.20*	**23.57**	-13.81*	**8.77**	-12.47*	**2.37**	-0.07*	**84.32**	-8.76*
Basmati Kasturi x Chakhao	**25.38**	6.41*	**29.55**	-4.60*	**9.61**	1.06*	**2.46**	5.08*	**145.12**	39.17*
Basmati Kasturi x Basmati	**29.02**	7.28*	**29.56**	13.14*	**9.68**	-11.52*	**2.16**	1.45*	**124.78**	27.66*
Basmati Kasturi x Chakhao Amubi	**25.47**	-5.65*	**28.85**	6.59*	**9.17**	-7.49*	**2.49**	3.97*	**100.45**	26.31*
Basmati Kasturi x Ching Chakhao	**25.38**	-14.31*	**28.26**	6.11*	**8.49**	-15.02*	**2.25**	-6.09*	**116.15**	30.63*
Basmati Kasturi x Chakhao Angangba	**30.50**	4.58*	**26.69**	-0.93*	**9.37**	-6.26*	**2.49**	0.36*	**108.42**	7.95*
Basmati 370 x Chakhao Poireiton	**28.46**	0.84*	**29.41**	11.92*	**9.57**	-4.58*	**2.45**	3.15*	**89.33**	-4.57*
Basmati 370 x Chakhao	**31.53**	25.56*	**31.61**	5.72*	**8.40**	-11.71*	**2.59**	10.49*	**100.25**	-4.96*
Basmati 370 x Basmati	**30.54**	7.88*	**31.34**	25.08*	**11.54**	5.39*	**2.10**	-5.14*	**86.49**	-12.59*
Basmati 370 x Chakhao Amubi	**23.57**	-16.59*	**35.47**	36.44*	**8.73**	-12.01*	**2.47**	2.85*	**47.11**	-41.63*
Basmati 370 x Ching Chakhao	**25.53**	-17.34*	**24.56**	-3.91*	**9.35**	-6.51*	**2.48**	3.58*	**125.11**	38.21*
Basmati 370 x Chakhao Angangba	**27.59**	-9.31*	**24.41**	-5.65*	**7.38**	-26.19*	**2.51**	0.70*	**72.40**	-28.76*
Chakhao Poireiton x Chakhao	**24.97**	0.81*	**28.75**	-6.72*	**8.33**	-8.88*	**2.42**	-0.30*	**130.41**	53.20*
Chakhao Poireiton x Basmati	**28.14**	0.61*	**31.79**	22.37*	**10.61**	0.32*	**2.36**	3.34*	**125.40**	59.56*
Chakhao Poireiton x Chakhao Amubi	**22.31**	-20.07*	**26.74**	-0.67*	**8.47**	-11.27*	**2.44**	-1.16*	**56.11**	-7.07*
Chakhao Poireiton x Ching Chakhao	**24.80**	-18.79*	**23.51**	-11.22*	**8.63**	-10.42*	**2.55**	3.27*	**126.16**	79.77*
Chakhao Poireiton x Chakhao Angangba	**32.48**	7.97*	**25.63**	-4.35*	**9.57**	-0.63*	**2.72**	5.97*	**78.43**	-3.52*
Chakhao x Basmati	**28.39**	14.17*	**32.64**	10.25*	**9.58**	-4.84*	**2.45**	8.18*	**123.88**	36.95*
Chakhao x Chakhao Amubi	**27.19**	9.62*	**28.19**	-7.71*	**9.43**	4.23*	**2.54**	3.69*	**103.47**	43.23*
Chakhao x Ching Chakhao	**24.27**	-11.52*	**28.50**	-5.33*	**8.75**	-4.12*	**2.57**	5.23*	**122.10**	48.82*
Chakhao x Chakhao Angangba	**27.96**	3.64*	**28.58**	-6.03*	**8.60**	-5.75*	**2.60**	2.37*	**64.57**	-30.68*
Basmati x Chakhao Amubi	**29.44**	5.13*	**31.71**	23.37*	**9.73**	-7.11*	**2.49**	7.57*	**74.90**	13.99*
Basmati x Ching Chakhao	**26.71**	-12.79*	**29.66**	17.41*	**9.27**	-12.14*	**2.51**	8.76*	**111.12**	47.15*
Basmati x Chakhao Angangba	**29.41**	-2.52*	**29.65**	15.93*	**10.25**	-2.92*	**2.53**	8.00*	**131.08**	51.33*
Chakhao Amubi X Ching Chakhao	**30.43**	-0.47*	**27.62**	5.44*	**7.56**	-20.61*	**2.52**	0.92*	**102.62**	79.11*
Chakhao Amubi X Chakhao Angangba	**31.37**	4.15*	**23.02**	-13.18*	**9.55**	0.17	**2.77**	6.98*	**65.64**	-4.04*
Ching Chakhao X Chakhao Angangba	**32.44**	-0.91*	**26.58**	1.93*	**9.66**	0.50*	**2.40**	-7.23*	**81.74**	4.52*
S.Ed. for MP		**0.13**		**0.18**		**0.14**		**0.02**		**0.44**
C.D. (0.05)		**0.26**		**0.37**		**0.29**		**0.04**		**0.90**

*** Signifies significant at 5%**